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OPTIMISING RESEARCH SUPPORT SERVICES THROUGH LIBRARIES: A REVIEW OF PRACTICES

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Optimising Research Support Service

Abstract:

In the changing landscape of libraries, the area of Research Support Service is emerging, with new opportunities, and challenges. The study is based on the role of the libraries in supporting research in the Institutes and Universities. This literature review identifies the current level of publications that deal with the relationship of the libraries and their role in the research process, and an examination of science researcher's information seeking needs, role of university libraries in supporting research, changing electronic environment and changing librarian's role, and challenges faced by the libraries with these changes. It aims to determine whether notable changes in the research support services for the doctoral students and scientists have emerged in recent years. The study shows that the support services of doctoral students and scientists provided by libraries follow a steady trend, with many subtle changes, particularly on the technological basis. The selected literature review spreads from 2000 to 2019. The coverage is balanced in that here on one hand the support service of the researchers, the researchers' information seeking need, the environment for the research is discussed, and on the other hand, the challenges for the libraries in print and electronic environment is discussed.

Keywords: Research Data Service, Research life cycle, Electronic journals, Artificial Intelligence, Library websites, Institutional Repositories, Metadata librarian, Virtual Research Environment, Research Data Management, Scholarly publishing, Social media tools, Data repository, Data citation, Data curation.

Introduction:

Research and the library are both interrelated. No good research is possible without a resourceful and technically oriented library. Easy access to high quality content provided by library is a key

foundation for good research. Repositories increase the visibility of the institution and raise its research profile. Besides, in today's environment, copyright advisory service and anti-plagiarism advisory service are becoming very much important to aware researchers. Different modern tools are used in the library like anti plagiarism tools, reference management tools etc. for assisting researchers and providing the utmost support in their research. Research Data Service can be provided throughout the campuses of an institute by providing expertise, tools and infrastructure necessary to manage research data during all phases of the research data lifecycle.

Over the last few decades, the services to support research have risen exponentially and are still rising in a hasty way which leads to a revolution in the scholarly communication. This paper reviews the literature charting the impact of research support service provided through libraries to the research scholars. This article restricts itself to an examination of those literatures related to research support services in the libraries of the scientific institutes and universities.

The aim of the review is to examine the support services provided for the researchers by libraries, not limited to a single country. The review begins with an overview of support services provided for research by libraries. The next section reviews researcher's information seeking needs, in terms of information sources, services and facilities, scholar's attitude and also the challenges faced for emerging research needs. It then moves onto examining the evolving role of university libraries in supporting research; how they are changing their service pattern with the ever changing technologies and researchers' need. Next is a review of research in the changing electronic environment, current trends and future developments, researcher's satisfaction and the obstacles faced for the shifting. Changing role of librarians with the changing use pattern; their training, librarians' need; motivation that increases their ability; changes in job titles are then discussed,

before finally moving to an examination of current challenges faced by the libraries in supporting the researcher's progress.

Method:

The focus of this study was on literature in library and information science, recognizing the in-depth coverage of research support service. Publications included were mainly from the past nineteen years and in English to keep the quantity of literature reviewed manageable. The focus was on documents enunciating or practically demonstrating institutional support system and library engagement in supporting researchers.

The main sources of identifying the literatures for review are Proquest dissertation publishing database, National Digital Library of India, PLoS ONE, Academic One File, Google scholar, Jstor, Web of Science, Ebsco databases. Also were included the Association of Research Libraries (ARL), the Association of College and Research Libraries (ACRL), Journal of Electronic Resources Librarianship, SRELS Journal of Information Management, The Acquisitions Librarian, Issues in Science and Technology Librarianship, Annals of Library science and Documentation, Webology, New Review of Academic Librarianship, The Electronic Library, Journal of Academic Librarianship etc. These were studied from the year 2000 to 2019.

Support Services for the researchers

Some investigators (Bourg et al., 2009) pointed some central role in support of scholarly research which includes "continual study of the ever-changing work patterns and needs of researchers; with adoption of new modes of research and publication, library content, services, and staff within researchers' regular workflows; integrating with services others provide (whether on campus, at other universities, or by commercial entities) where such integration serves the needs of the

researcher; reassess all library job descriptions and qualifications to ensure that training and hiring encompass the skills, education, and experience needed to support new modes of research and offer alternative scholarly publishing and dissemination platforms that are integrated with appropriate repositories and preservation services" and Cox and Pinfield (2013) put forward some services on research data management such as open access and policy, copyright advisory, data citation, awareness of reusable sources, external data sources, RDM plan advice, web portal, data repository, metadata, data analysis, and data impact. They also enunciate that libraries clearly need to collaborate with IT services and researchers along with other key sections such as research support offices, whereas at the same year Corrall et al. (2013) pointed out that bibliometrics are the most extensive services supporting researchers, including bibliometrics literacy or training, calculations of research impact, citation reports, disciplinary research trend reports, h-index calculations, evaluation of candidates for recruitment, promotion and tenure, and grant application support . Kennan et al. (2014) also shows that the greatest area of demand for research support services was RDM, followed by data curation, bibliometrics and related services such as citation analyses, altmetrics, and impact measures, systematic reviews and/or literature searching and digitization of archives, records or data. This study also reported the skills which librarians are asked for providing these services are data curation skill, technical and ICT skill, Knowledge of research processes, Knowledge of research methods and oveall the subject and/or disciplinary knowledge .

In 2015 Lijun and Lijing proposed two categories of supporting services for researchers: services needed at the entire research process (e.g. research consultation, technological services and literature access) and services needed at different research stages (e.g. fund application, RDM, thesis writing and dissemination of research results). Next year Xue et al. (2016) introduced a

research support services model based on the research lifecycle, which includes the following steps such as conception (research consultations, research guides, workshops, etc.); data processing and analysis (RDM, research tools, data analysis, writing help, etc.); publication and sharing (scholarly publications, OA, citation management, copyright services,); and preservation and curation (institutional repository). In the same year a new service named Academic support services was introduced (Silva, 2016) in three Australian universities which includes research support, technical writing skills, computer support, milestone preparation support, language support and research commercialisation support. All three universities had dedicated offices to cater to support and develop research students. Courses on using referencing tools such as Endnote and specific academic databases, technical writing skills support, language support services are provided. Commercialisation support is of particular importance in the areas of Engineering and IT, given the potential for patent and IP issues related to research outcomes.

Next year Haddow and Jayshree (2017) states training sessions for researchers, as workshops or individual consultations, was the most frequently offered research support service. Researcher's demand and awareness of research support services was an important factor in both the level and type of service whereas Coombs et al., (2017) describes how a Community of Practice CoP approach to research support has evolved in UK and examines the experiences of its members. A regular series of short informal workshops on key research topic areas was delivered to both research students and faculty. A "research life-cycle" one day conference was organized and included presentations and workshops on research data management (RDM), research impact and visibility, reference management etc. A monthly drop-in service was created to assist PhD students with literature search and writing skills for their thesis. A small, informal group meeting on a monthly basis was created to discuss topics related to writing at the doctoral level and provided

peer-to-peer writing feedback. In the same year some investigators (Gibson and Houpert, 2017) expressed some researcher's wishes for support, such as workshops on software, such as statistical software; for someone to support the production of literature reviews to support projects. Librarians would help the researchers to find materials and set up assignments, as well as teach classes in relevant databases and other tools. Cox et al. (2017) and Zhou (2018) both worked on research data management services, a vital part of research support system provided by libraries. Cox et al. (2017) reported on an international study of research data management (RDM) activities, services, and capabilities in academic libraries. The results indicate that libraries are providing leadership in RDM, particularly in advocacy and policy development. Service development is still confined, focused on advisory and consultancy services (such as data management planning support and data-related training), rather than technical services (such as provision of a data catalog, and curation of active data). Data curation skills development is underway in libraries, but skills and capabilities are not consistently in place and remain a concern. The range of RDM activities explored in this study are positioned on a "landscape maturity model," which reflects current and planned research data services and practice in academic libraries . On the other hand Tenopir et al. (2017) focuses on two types of research data services namely consultative research data service and technical research data service. Creating web guides, direct participation with researchers on a project, and providing reference support for finding and citing data/sets are the three major areas raised under consultative research data service. Deaccessioning of data, Selection of data/sets for repository, preparing data/sets for deposit, creating/transforming metadata for data/sets are offered under technical research data service.

Next year Ogier and Stamper (2018) claimed for a new research consulting service named 'data visualization' where the data is shown in a visual manner using graphs, charts, animations etc.

which helps the researcher to come to better conclusions or come up with more refined questions. Patterns can be detected, trends can be predicted, and decisions can be made more quickly by looking at the story within the data whereas Zhou (2018) explores the process of conducting research data management services and provides effective recommendations for academic libraries to conduct data management services. The service content includes research data management plan, metadata service, research data storage, research data mining and sharing, data discovery service, research data reference, research data literacy cultivation services. He also stated that the university research data management service is still in its infancy. It needs to go through such links as policy formulation, infrastructure construction, service content design, service team formation, service user mining, and service fund raising. These links together constitute the practice of research data management.

Lastly Si et al. (2019) divided the research support services into seven aspects, such as research data management, open access, scholarly publishing, research impact measurement, research guides, research consultation and research tools recommendation. He also proposed to offer targeted consulting service and training to those who have difficulties in learning and mastering new techniques and tools. Therefore, academic libraries are supposed to set specialized research support sections and set a clear navigation, bringing together all the research support services to make it more standardized and scientific.

So if we analyze this theme, we find that most of the researchers like Cox & Pinfield (2013), Kennan et al. (2014), Cox (2017), Zhou (2018) and Si et al. (2019) emphasized on research data management services for enhancing a good support service for the researchers ; but Coombs et.al (2017) & Silva (2016) stress on community of practice approach , and also research

commercialization support services for the researchers ; whereas Ogier & Stamper (2018) relies on a new type of research consulting service , i.e. ‘ data visualization ‘ service.

This section is perhaps the most important part of this article. The work of approximately fifteen researchers are highlighted here. Most of the researchers have focused on Research Data Management as the most important part of support service. Apart from this, data visualization, or consultative data services, research commercialization, community of practice approach have also been emphasized as essential support services.

Researcher’s information seeking need

The researchers’ information seeking need is directly related to the support service. The review of the literature on researcher’s information seeking needs reveals that researchers from different background rely on different types of resources; their library use pattern is also different and the problems they are facing are also different. The study depicts interesting reads of information seeking habits of scientists. The study also depicts that some researchers are partially satisfied with the resources and services provided by the library, and others are fully satisfied by the services of the libraries. There are many available resources that depict the information seeking needs and patterns of researchers from 2000, and how their needs change from time to time, balancing with the advent of technologies. These are discussed below.

(Biradar and Kumar, 2000) showed a general view that large number of teachers and research scholars used the subject periodicals most frequently in the university environment. They are in need of more secondary periodicals and of online and CD-ROM database search facility in their library. Four years later some investigators (Farrell et al., 2004) highlights that academic libraries develop collections and services for scholars who use video games in teaching and research. The

authors reveal how the University of Minnesota Libraries can facilitate access to games and technology. The findings can inform needs-based multidisciplinary strategies to develop video game services and collections relevant to unique academic communities. In the same year (Khot and Patil, 2004) a survey was conducted to know the use pattern of library sources and services by the science research scholars in the Shivaji University Library, Kolhapur. The study revealed that 90% of the respondents visited the library to use theses and dissertations. The study found that reference books, followed by theses and dissertations were the most preferred resources used by the researchers. The study also found that 95% of the respondents were satisfied with the reader guidance/assistance service and 90% with reference service. Regarding library facilities, 90% of the respondents were satisfied with the space for reading facility, 85% with cleanliness, 80% with drinking water and 75% with lighting facility. Next year Asemi (2005) in his study reported that 55% of the researchers searched for scientific information through Internet as their university library had provided access to various databases and online journals for all students and staff. Internet was also used by the respondents for downloading software or text, chatting, discussion, e-mail services and for finding related references. Google and Yahoo search engines were more widely used as compared to other search engines. In the same year some investigators (Patitungkho and Deshpande, 2005) also agreed that the Internet had been almost universally adopted; they trace materials from the library via the internet. Google.com was used for searching information by researchers. They use frequently e-mail for communication. It is found that 42 percent of researchers use the ERIC (Education Resources Information Centre) database. Atilgan and Bayram (2006) determine the level of awareness of digital library resources, particularly journal articles and to evaluate the preferences of research scholars and faculty members for specific electronic databases at Ankara University, Turkey. The majority of respondents were aware of digital library

resources, electronic databases and the most preferred databases were Web of Science and Science Direct. Four years later, Nui Xi et al. (2010) conducted national wide survey in the United States to know the information seeking needs of researchers. The biggest changes is their search pattern has been seen because of increased utilization of electronic methods for searching, sharing, and storing scholarly content, as well as for utilizing library services, whereas it has been noted by Kumar et al.,(2011) that the working culture of the individual requiring information is very vital- the importance is placed on getting it, the facilities available for seeking it, the knowledge about these facilities, the judgment of their value and the probability of getting what is wanted affects the researcher's information seeking behavior. Johnson et al. (2015) used participatory and service design methods to identify emerging research needs and existing perceptions of library services among science and engineering faculty, post-graduate, and graduate student researchers based at a satellite campus at the University of Colorado Boulder. This article uncovers the barriers in the research processes of a user population without a dedicated physical library. The barriers mentioned in this article refers to accessing information behind paywalls, decreased grant funding, proprietary formats and improperly documented resources.

Brewerton (2012) established that the best way to know researchers' information needs was by employing a "research life cycle" approach. Another aspect of the study was to audit the skills needed by subject librarians now and in the future, and to assess areas where the librarians in the research institutes needed to develop skills sets. Thirty-two skills and knowledge areas were identified, focused specifically on the support to be given to the researchers. He concludes that combination of developing new roles, new skills, and new partnerships can help the professional librarians to effectively and efficiently extend their help and meet a wider span of researchers'

needs. Vasappa and Shivalingaiah (2014) identified the preferences of the researchers over channels of information, various modes of literature search, purpose of visit, type of information gathered, frequency of library visit and time spent in the library. Recently Bussell (2017) reports on a study of research needs and learning preferences of graduate students at a public research university. The article concludes with a discussion of the value of the sequential exploratory mixed-method design for informing researchers in an individual institution.

Analysis of this part shows that the role of digital culture and internet was a main area where the researchers focused upon—this is visible in the works of Asemi (2005) or Patitungkho & Deshpande (2005). But some authors have given the idea that personal prferences or personal culture, including working culture was nonetheless important. These authors include Kumar (2011) & Vasappa & Shivalingaiah (2014). A very different type of approach is shown by Brewerton (2012), who suggests a 'research life cycle' approach.

Research support services can never be complete without an understanding of the researchers' information seeking behavior or need. In this part, the work of twelve researchers has been discussed. An unique observation emerged which shows that these twelve researchers have dealt with this topic from different angles. But as a whole, the result came out that this need depended on the different types of resources the reserachers used, their library use pattern, their level of awareness and their working culture.

The evolving role of University libraries in supporting research

The information seeking needs and the role of Universities in supporting research is very much interwoven. Different Universities produce the highest number of researchers than any other

institutes. Therefore, providing the effective support service for research is the main motto of the libraries of any university. Several studies have been done to analyze the awareness, adequacy and the extent to the use of the library sources, tools, facilities and services provided in university libraries to support research. Current awareness, reference and reprographic services have been ranked high in order of preference by the researchers. Printed material was still used for reading and was a part of research in almost every discipline. Some reviews also indicate the factors that influence the usefulness of available resources in the library by the researchers. The future of the university research library, which are updating and transforming their workspace of human resources and technology, also came out through the literatures. Through the studies mentioned below it can be clearly depicted what the universities are doing to support their research system and how the universities are relying on electronic resources more, keeping in mind the latest technology and researchers' information seeking needs. It is seen that, from the twentieth century there was a transformation in using the electronic means rather than the old traditional resources and services.

In twentieth century, the most active users of electronic journals were the younger members of the teaching and research staff. It was noted that 48.9% of the respondents preferred the electronic version of the titles, 28.2% the printed version, and 22.9% expressed no preference (Bar-Ilan et al., 2003) whereas a survey was carried out by Tenopir (2003) in the same year and it was found that the printed material was still used for reading and was a part of research in almost every discipline. The use of e-mail and internet also came into view that year as examined by Mugwisi and Ocholla (2003). They examined the Internet use trends by academics and librarians at the universities of Zimbabwe and Zululand with specific reference to the use of resources for research

and training. The results indicated that e-mail and the web were used most for personal use, while telnet, other library OPACs and electronic journals were used most for work purposes.

Next year a study (Nyamboga et al., 2004) found that E-mail and search engines were the most frequently used applications of the Internet at Egerton university library, Njoro-Kenya. Library staff and users need training in the use of Internet. Besides, the charges for Internet within the university libraries and other university service points were exorbitant and somewhat prohibitive.

These were the scenario in 2003 and 2004 but three years later in 2007, it was found that students had less use of offline databases because of infrequent periodic orientation and lack of awareness on use of offline databases, and very few terminals are connected to the server in the central library. Users faced problems like low speed connectivity and shortage of hardware facilities (Asemi and Riyahiniya, 2007). The purpose of visit by research scholars was mainly for accessing electronic resources. Many university libraries did not have adequate Research Reports collection and Index collection for information search by scholars (Sheeja, 2007).

Two years later Zhao (2009) constructed the personalized information service plan for China Agricultural University Library. It gave support for the further development of personalized library and information service; studied the main technologies and practices of the personalized library and information service.

Next year some investigators (Mashroofa and Jayasundara, 2010) evaluated that the staffs of university libraries of Sri Lanka was prompt and helpful in delivering most of the information services to their users. These universities had user education programmes through trainings, library tours, orientation programmes etc. Considering the usages of e-journals; the respondents were 93.75% from University of Colombo and 72.7% of from University of Peradeniya, 63.63% of

South-Eastern University of Sri Lanka as well as in Sabaragamuwa University of Sri Lanka. Variations in service levels were seen in the periodicals based information service rendered by the four university libraries.

Again after a gap of two years, Kaur (2012) investigated the present situation of information sources, services and facilities provided in the libraries of Punjab, Punjabi and Guru Nanak Dev Universities and their research scholar's usefulness. He also identified the growth, development and current status of these three university libraries, factors that influence the usefulness of available resources in the library by the researchers and also the researchers' opinion about the research facilities and services available.

Next year Cawthorne (2013) highlighted the future of the university research library, which are updating and transforming their workspace of human resources and technology for their betterment and up gradation to serve the best to their researchers' community.

Recently Sterman and Clark (2017) said that 'many research libraries are looking for new ways to demonstrate value for their parent institutions. Metrics, assessment, and promotion of research continue to grow in importance, but they have not always fallen into the scope of services for the research library.' They revealed that Montana State University (MSU) Library identified some need to calculate the citation record and scholarly output of their university and began to arrange the citation collection, deposits into their Institutional Repository and make assessment of their research activities.

In short, this portion focuses on the use of email and web, which has been dealt in detail by Mugwisi & Ochella (2003), & Nyamboga (2004) for the new role of libraries in supplementing research. On the other hand, Tenopir (2003) is of the opinion of the existence and popularity of

print materials till date. Again, metrics was found to be applicable in measuring the output of University libraries in supplementing research, by Sterman and Clark (2017).

The special role of University libraries in supplementing research was stressed in this section. Here it is seen that the authors opined that both printed and digital material were in demand, and University libraries supplied these to the researchers. Apart from this, some methods like user education programs, library tours also occupied a prominent position in the role of University libraries.

Changing electronic environment in supporting research

The research support system varies with the changing environment. With the advent of technologies and internet, services and support provided to the researchers also changed with time interval. The review of literature provides a lucid picture about the current trends and future developments of the services; researcher's satisfaction with this environment and the obstacles faced by research scholars for the shifting of electronic technology. Researchers are in need of more computers with high speed internet access and other peripherals. Personalized library and information service is the one by which each and every researcher will be benefitted to their extreme. With this changing environment, information explosion and distraction from the main research topic becomes one of the major obstacles of accessing the internet. Center for Research Data and Digital Scholarship (CRDDS) are the new steps which came out as the latest research support system.

Madhusudhan (2007) examined the current trends in information search through Internet by the science research scholars and type of problems faced by them in their research work. The study finds that the researchers are facing the problems of inadequate computers with Internet facilities,

slow Internet connection and lack of skills and training. This scenario gradually changed from the next year and the faculty in the field of natural sciences and health sciences gave the strongest support for the transition from print to e-only. Three-fifth of the respondents, regardless of discipline, reported that the major barrier to use of e-journals was the lack of sufficient subscriptions in their discipline (Dilek-Kayaoglu, 2008).

Two years later Sekar and Rajendran (2010) states that the use of networking technology in the research process leads to bestow the quality and excellence among the researchers. The authors discuss the various networking technologies which are in great use among the researcher community in the present era. Intelligent Tutoring Systems (ITS) are computerized educational systems that incorporate artificial intelligence methods. Artificial Intelligence attempts to stimulate human senses, thought processes, and actions. There are three areas of Artificial Intelligence which are totally changing the dimensions of a library. They are Neural Network, Virtual Reality, Knowledge-based (Expert) Systems, Robotics and Creative Machine.

Library websites came into view as an information gateway, linking e-learners to library catalogues, subscribed journal databases, electronic book collections, selected Internet resources, electronic course materials, and tutorials, and to forums for communication and interaction with librarians. Libraries are maintaining institutional repositories which contains materials pertaining to the institution such as conference proceedings, thesis, published papers, lecture notes, video or audio clips. Many libraries are maintaining social networking sites like Orkut and Facebook to get users' feedback, ranking for services, library notices, etc. In the web 2.0 environment, the social networking sites are providing improved library services. Library services are integrated with Library Management Softwares such as WebCt, Blackboard, DesireLearn, ANGEL or Moodle in

such a manner that a single login makes possible access to all course components, direct links to e-journal articles, interlibrary loan, online interactive reference services and content resources to the Library Management Softwares (Mathew, n.d.).

Researchers' satisfaction is also a crucial factor to look after in a changing environment and it came into view after a gap of four years. Khan et al. (2014) explore the researchers' satisfaction with digital library resources and services and how they improved the research culture in Pakistani universities. The findings of this study are valuable for university library authorities, policymakers, and LIS professionals, both in Pakistan as well as in other countries and also for academic libraries to provide effective information resources and services, and to meet the information needs of researchers on a priority basis. Major obstacles faced by science research scholars are overload of information and distraction from the initial purpose for accessing the Internet (Divya and Pillai, 2015). To deal with this problem Akeriwa et al. (2015) studies that use of social media applications and mobile devices are the two latest technologies that academic libraries are leveraging to enhance their overall service delivery. They also noted some of the frequently used social media tools includes blogs, RSS feed, social bookmarking/ user tagging, wikis, social networking sites, podcasts, and instant messaging. Mobile interfaces, mobile collections and databases, Google books, mobile reference services, mobile instruction and mobile tour of the library etc. are providing easy dissemination of information among the users.

Two years later accessibility of online resources was disclosed as the most important element of an academic library website and as the governing information need among the scholars. Digital presence of academic libraries still poses challenges and requires observation of user information behaviors with redefined librarian's roles (Mierzecka et al., 2017).

In the same year another study was done (Knuth et al., 2017) which highlights that The University of Colorado-Boulder expanded its digital services through the 2016 opening of its Center for Research Data and Digital Scholarship (CRDDS), collaboration between the libraries and research computing.

Artificial Intelligence came out as a very crucial element of library systems and services in today's environment which made the most upgraded and intellectual libraries in the world. Mogali (2014) in his paper, discussed the various concepts of artificial intelligence such as expert system, natural language processing, pattern recognition and robotics and their application to the libraries. An attempt has been made to trace the different applications of Artificial Intelligence to the libraries. Applications of Expert Systems in Reference Service like REFSEARCH, POINTER, Online Reference Assistance (ORA), ANSWERMAN, PLEXUS; Application of Expert System in Classification like Coal SORT, EP-X, BIOSIS, has came out very effectively through this article.

Two years later Otterlo (2016) reports on the underlying motivations of the ongoing project BLIIPS to make libraries more intelligent by data-driven optimization. Its core aim is to use smartphones and related technology to sense and record how patrons interact with the physical library and its books, and to aid a patron in navigating to "possibly interesting" books. The results of the project will be beneficial for patrons, library management and science. Location-aware mobile library service, RFID chips, PDAs, virtual reality, and augmented reality – which allows for additional information being projected onto images, or which can recognize books and objects using the smartphone camera, are some of the issues discussed here.

Again in 2018 Shrivastava explored a comprehensive list of potentially useful Artificial Intelligence tools and techniques which includes Knowledge base, Inference engine, User interface, Domain expert, Knowledge engineer, Explanation facility, Blackboard and Reasoning

improvement. Genetic Categories of Expert System (ES) applications are also discussed here which includes Rule-based ES, Frame-based systems, Hybrid systems, Model-based systems, Ready-made systems and Real-time systems whereas Asemi and Asemi (2018) applied Exploratory Factor Analysis (EFA) as a primer method for identification of the most applicable Artificial Intelligence techniques categories in Library and Information Science. In this study four criteria for the application of AI in the library systems were considered and it is determined in three areas, including public services, technical services, and management services. AI also can be utilized in many areas such as speech recognition, machine translation and librarian robots. Then degree of development of these services was studied here, using taxonomy method. The results showed that most developed Recommender Systems (RM) in library systems and Natural Language Processing (NLP) is the most undeveloped criterion. A model has come out through this article named Asemi's model for library system development assessment in using Artificial Intelligence.

Massis (2018) states that AI can influence the partnerships with the library in academics within the areas of research and scholarship. The library could deliver audio reference responses and citations to those students researching and writing papers from the comfort of their own personal spaces. Rather than engage in an open search of the most widely used search engines, such a virtual search could be combined with access to library resources, so that items held in the college's databases could deliver a much more targeted approach to information retrieval for students.

Recently in 2019, Nonyelum explores different Artificial Intelligence applications in library system, like descriptive cataloguing, technical services, and collection development; subject indexing, reference services, database searching, and document delivery. Artificial Intelligence involves in various areas of researches, such as: expert system, fuzzy logic, artificial neutral

network, evolutionary algorithms, case based reasoning, image processing, natural language processing, speech recognition and robotics.

Though artificial intelligence is showing its way in the research support areas of libraries, it has it's disadvantages too. One of the challenges confronted by application of AI is that there are a number of difficulties which are found in allowing the end users to adjust to the exoert systems to meet their needs. Not only this, but the limitation of natural language capabilities also poses a problem for the proper implementation of AI in research support services. In all these case the researchers need to acquire great data literacy for improved using of research data management.

Here two distinct opinions have emerged-on one hand works by Sekar and Rajendran (2010), Madhusudan (2007), Khan et al. (2014), Akeriwa et al (2015) show the reflection that searching modes of information through internet and use of mobile devices by research scholars ; on the other hand, that the role of AI is evolving is shown by Moguli (2014), Srivastava (2018), Asemi and Asemi (2018), Massis (2018) and Noryelum (2019).

In this part, the role of artificial intelligence, use of social media, major obstacles faced by science researchers have been dealt with. Stress has been given on the role of AI in supporting research.

Changing role of librarians in higher education

The role of librarians in the changing environment is very crucial. As the time passes, the role of the librarian changes in terms of user's need and expectations. To provide the effective research support service, keeping in mind the changing use pattern also brings changes in the librarian's working system. There was an urge to identify the changes that are happening in the working environment, what training librarians need, what are the factors that increases their ability. Several studies have been made in recent years to deal with this situation by providing solution to this

especially after 2011. The year 2011 is stressed here because as far as our knowledge goes, before this year only a handful of studies were there to provide solution to these problems. In 20th century as the technological environment unfold its upliftment, several changes in the librarian's work has been made and a new arena of library services has come across. Different researches related to the changing role pattern are given herewith that clearly shows the changes in librarian's role and how efficiently they are dealing with this changes.

"Librarians are expanding the range of resources for the benefit of users especially to include those available in electronic format, viz. web-based or web accessible information resources. Librarians are evaluating information resources, connecting users to the information they need, and organizing information for easier access by the users. With the advent of web based resources, librarians are finding that their role as information intermediaries, that demands a new sub-set of quasi technical skills and awareness. Librarians must not only identify and facilitate access to the electronic information resources; but also educate library users about how to access them and when to use them" (Kumbar and Hadagali, 2005).

Venkata (2006) discovered librarians need to become an information knowledge navigator who distills data into usable information. Some of the unique competencies of the LIS Professionals are discussed here like managerial skills, knowledge of policies, procedures, issues and standards, knowledge of information sources & services, technology skills, professional search skills, communication skills, presentation skills, customer service, commitment to life-long learning, evaluation and assessment skills, marketing and promotion of library services. LIS professionals are striving, struggling and improving new skills and knowledge about new technologies that will be needed to provide responsive Library Information Services to the users in the twenty first century. In the same year Gaddagimath et al. (2006) depicted there has been a paradigm shift in

the library services and the role of information professionals. With the enhancement of the library services, librarians are upgrading their roles by acting as an information therapists, educator, content manager, innovator in service excellence etc.

Next year Chapman (2007) defines four roles that define the position and its mandate in the library, and also discusses the crucial factor of librarianship in pursuing these roles. He identified common responsibilities or roles and categorized them as collaboration, research, education, and development. Acting as a researcher, the metadata librarian must maintain a knowledge and familiarity with the new developments in the field. As educator, metadata librarian ensures that procedural and workflow changes are accommodated as easily as possible. The metadata librarian helps to develop methods to migrate, convert and enhance metadata. Being a developer, a metadata librarian is aware of the complexities and particulars of metadata schemas.

Wusteman (2008) identified the role of a librarian in Virtual Research Environments (VREs) and Virtual Learning Environments (VLEs). The potential role for librarians relating to VLEs was described as 'Facilitator for e-learning, supporting Virtual Learning Environments', whereas the role relating to VREs was listed as 'Technology specialist, creating and managing Virtual Research Environments to support Virtual Research Communities.

Competencies of metadata librarians were determined in comparison with those of cataloguing librarian in 2009. Mentioned job titles are metadata coordinator, metadata/serial specialist, metadata indexer, cataloguing/metadata services librarian, metadata archivist, GIS/metadata librarian, metadata/ digital collection librarian etc. Cataloguing librarian positions remains focused on traditional cataloguing responsibilities carried out in a predominately MARC-based cataloguing

context within academic research libraries. On the other hand, emerging and evolving job of metadata librarian encompass a much broader suite of metadata implications, demanding familiarity with an array of formats, standards, schemas, tools and best practices (Han and Hswe, 2009).

After a long gap, Bracke (2012) explored the ways in which academic librarians express their perceptions of changes in higher education, changes in the sociotechnical environment of information, and of changing professional jurisdiction and relationships. The study analyzes strategic plans from 75 American research universities from the membership of the Association of Research Libraries and the Association of American Universities.

Next year Virgil (2013) examined the academic library and the changing role of the academic librarian in higher education through the following decades: 1970s, 1980s, 1990s, 2000s and in the 21st century. The changing role of the academic librarian, motivated by changing media and technology availability was reviewed by decade.

Later (Brantley et al., 2017) scholarly communication training developed for librarians at a mid-sized public university is described. Two surveys are conducted to describe faculty digital scholarship needs and librarian attitudes toward scholarly communication. Proactive promotion and articulating scholarly communication support are identified as the developing role for librarians.

In this same year another article was bought out by Pasek (2017) which describes the evolution of access to United States government information in relation to scientific research funded by federal grants. It analyzes the data sharing policy of the National Science Foundation, which requires inclusion of a Data Management Plan in research proposals seeking agency funding.

"Support from the librarian included: verifying proposed research has not already been performed; searching literature to provide background for the project; and advising on or writing systematic review methods" (Otter et al., 2017). This review article found three examples where librarians were involved: in writing sections of the application; conducting reviews, and becoming a co-applicant. They recommend that librarians engage with researchers by checking whether search requests are to support an application and by becoming familiar with resources and techniques to support grant proposal development.

"Five factors that influence the ability to support researchers' needs i.e. technical resources, human resources, researchers' perceptions about the library, leadership support, and communication, coordination, and collaboration." The main aim of this article was placed here. Support was offered through consultation, education, and outreach primarily. Given the early stages of RDM programs, this study focused on what librarians perceived as influences on their ability to support researchers' RDM needs. Findings indicate many librarians did not have the time, money, or full range of expertise needed to support RDM over the lifetime of the data and suggest partnering with other stakeholders to support the range of services needed. Findings also indicate that most librarians acknowledge and rely on existing disciplinary repositories when possible. Findings suggest librarians consider pooling expertise and resources with libraries at other institutions, which may reduce duplication of effort and demands on staff time. Based on the five influencing factors found in this study, the findings suggest that librarians can pursue these opportunities through broad-based leadership support across the different service organizations on campus and increased communication, coordination, and collaboration with these service organizations and those at other institutions (Faniel and Connaway, 2018).

All the authors are of the opinion that the librarian is the information and knowledge navigator who has a role to educate library users about how to access information resources; and thus they are navigators too.

This section is comparatively small, and here researchers have dealt with the role of librarians as information and knowledge managers who distils data into valuable information and also educates library users.

Current challenges for libraries in research support

The role of libraries and librarians are interconnected and are the two sides of the same coin. With the changing environment and changing roles of the librarian there initiated different challenges for the libraries too. It is important to know these challenges that libraries are facing to provide the effective research support service. Collection developments are the major challenge faced by today's library followed by financial crisis. Libraries need to monitor the changing workflows, information needs and information-seeking behavior of researchers to effectively meet their needs and provide valued services. Libraries need to market their resources and services to the research community to gather their attraction and make use of the library materials at its fullest. Institutional review board can make a library to a well-known position to its research community. There are many studies done to examine these challenges facing by the libraries. A review of different research on the challenges faced by the libraries in providing research support services is chalked out herewith.

Fenner and Fenner (2004) explored the New Thought movement's conceptual and historical development and applied this outline to the selection of library resources. A sample collection development policy was included; such a policy is the framework for selection decisions. Special

problems and concerns of gathering resources were presented, including library mishandling in the past. Titles in the core collection were presented, incorporating several types and formats of materials and varied points of view.

After four years, a book was initiated by Webb et al. (2008) that examines the current challenges for libraries in supporting research, collection management of libraries to support research, researchers learning style, habits and attitudes, influences on resource use, services provided by the library to facilitate research, training needs of researchers on how to use the library resources. They also highlight the possible research information environment of the future, principles of library support for researchers etc.

The academic library manifesto published by OCLC highlights the roles academic research libraries can assume to better support the research enterprise. This manifesto includes a call to action for academic libraries to understand the work patterns and needs of researchers, embed library content and services within researchers' workflows, and find ways to demonstrate the value of library services to university administrators. The strategies discussed here are first steps to augmenting the relationship between the library and the research community and enhancing the library's profile within the university. Libraries will have to continuously monitor the changing workflows, information needs and information-seeking behavior of researchers so that they are able to effectively meet their needs and provide valued services (Bourg et al., 2009).

Two years later Healy **(**2010) opined academic libraries support their universities' goals of developing and maintaining successful research programs. He says to garner the support needed from their institutions to support research activities, libraries may need to better market their resources and services to the research community. This article explores some aspects of the

academic research enterprise and identifies the opportunities a library can use to make a well-known position in the research enterprise as well as increasing the visibility among the research community such as institutional review boards and technology commercialization.

Dora (2015) explores the role of libraries and library professionals in Research Data Management (RDM) services and discusses the importance of research data, its preservation, organization, dissemination and critical role in the scholarly research life cycle. Research data registry, repository and softwares are the main points for research data management comes out in this study. He also presents a case study of CKAN software and its implementation at Indian Institute of Management, Ahmedabad which can be used for creating and preserving research data. The novelty of this paper lies here.

In this year another article was brought out by Stuart (2015) that examined the little research existed to document academic research libraries' changes during this period in history, or how the role of the academic research library evolved during this period. Through interviews with the library leaders at four public, doctoral, comprehensive research universities in Florida, this qualitative multiple case study explored how four academic libraries were reframed, using the analytic lens of Bolman and Deal's (2008) theory of reframing organizations. The main objective of this article is to provide a clear understanding of the activities of these four libraries in reframing their organizations may help the future evolution of academic libraries in higher education.

Ward and Richardson (2016) shows that many librarian-selected e-book titles suffer the same fate as the traditional model of librarian-selected print books: many receive little or no use. The PDA (patron-driven acquisitions) model is far more effective, both by making large numbers of titles available and by leveraging tight collections budgets. This paper analyzes cost and use factors of

three years of data from the Purdue University Libraries' PDA plan, and examines the same factors for librarian-selected e-books during the same time period. The authors conclude that it may be time to consider moving PDA from its current role as a small ancillary collection development tool to become a major component of an academic library's monograph collection development program and to suggest that selectors modify their title-by-title selection habits for e-books.

Dempsey (2017) investigates how reference staff at two libraries balance teaching with resource delivery in live chat reference. Two possible reasons for differences are reference policies and staffing models: one library states that chat is for brief factual questions and monitors chat from a public service point; the other does not state a policy and monitors chat from private offices. Findings are important for staffing responsively, developing effective research guides, and improving teaching in online environment.

In recent years, evidence has emerged from disciplines ranging from biology to economics that many scientific studies are not reproducible. Sayre and Riegelman (2018) introduce the reproducibility crisis and then discuss how academic libraries can lead institutional support for reproducible research.

ACRL's "2016 Top Trends in Academic Libraries" noted a "shift to the incorporation and integration of more continuous, ongoing, flexible, and sustainable review of collections," and "an increasing need" to align collection development with "institutional research and curricular requirements." (Linden et al., 2018). This article describes these trends playing out at a top-ranked research library. This article also examines the monographic acquisitions program from multiple angles, including circulation, expenditures, approval plans, and e-book usage.

In this section, the authors are of different opinions regarding the challenges for librarians in research support. Some have resorted to models like PDA model (Ward & Richardson, 2016), whereas others have seen the personal qualities like upgrading their skills as content manager, different roles of librarians and proactive librarian.(Gaddagimater et al. 2006), Han and Hsnoe (2009) or Brantley et al. (2017).

A very important part of this article, this deals with the work of approximately 13 researchers. A number of challenges are being discussed in this section. But all the authors are unanimous in their views in that a proactive, articulating scholarly communication is a must for the librarians of the future. Not only this, but the role of the librarian in virtual environment has also been stressed. Other works include a better reference service too.

Conclusion:

The need for optimal research support service through libraries initiated countless investigations and studies. As the literature reviewed here shows, research support services are now a fundamental part of any academic libraries where ongoing research programs occur. Researches and implementation of the probable solution in different situations led to the evolution of new techniques involved in supporting researchers in their progress. Since our main approach is to assess the research support services provided through the libraries, it confide on the researcher's information seeking needs in any organization. Researchers from different background rely on different types of resources; their library use pattern is also different and the problems they are facing are also different. It is very important to perceive the researcher's concernment before initiating any support service within any library. Information literacy programmes improve their information searching and retrieval skills. Current awareness, reference and reprographic services ranked high in order of preference by the researchers. Calculating the citation record and scholarly

output of any institution and beginning to arrange the citation collection, deposits into their Institutional Repository can make a better assessment of their research activities. With the emergence of technologies and internet, researchers are facing problems like inadequate computers with Internet facilities, slow Internet connection, overload of information and lack of skills and training. Center for Research Data and Digital Scholarship (CRDDS) are the new steps that came out through the literature review as the latest research support system. A proper integrated and well organized website is also a crucial factor in today's circumstances. Up gradation of technology and media are the main motivated factors to the librarian in raising up themselves along with proactive promotion and articulating scholarly communication support and to confront with this changes made in the environment. The libraries will succeed in proving it's importance to the researcher community only if it aims to be the centre of expertise and innovation, regarding the whereabouts of all types of scholarly information. Libraries need to market their resources and services to the research community to gather their attraction and make use of the library materials at its fullest. Institutional review board can make a library achieve a well-known position to cater to its research community. Since new skills and technology are changing, therefore there is needed a deeper understanding and new skills of the research subject matter by the library staff. In-depth knowledge of the research process in specific discipline areas may be required to enable the librarians to contribute as an active partner in the research activity. A good solution will be an active collaboration between faculty, institutes, centres and libraries. Libraries will then be considered a research hub because it will incorporate spaces, technology and services, which are so very essential and required by researchers across different disciplines. However, permeating all recent research is the dominance of electronic environment provided through the libraries and access to it is permitted by keyword searching. Universities and institutions over the world have

come forward to increase the awareness about two very important aspects of academic integrity, one is plagiarism and another is reference management among the teachers and researchers, and providing them free access of these tools through their libraries and websites. It has been found that North American libraries are more aware in using these tools than Europe, and United States is the highest in this case, occupying almost 60% of credit in the world countries. Whatever may be the situation, it is seen that antiplagiarism and reference management tools play a great role in assisting the researchers in their research work by their assistive technologies. The conclusion can only be that it is now unthinkable for the researcher community to work without the convenience and expansiveness which the libraries are providing to them.

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